
फलैज कार्य एवं अभिरूपण हेतु तप्त
बेल्लित इस्पात की चादर, प्लेट एवं
पत्ती — विशिष्टि

(चौथा पुनरीक्षण)

Hot Rolled Steel Sheet, Plate and
Strip for Forming and Flanging
Purposes — Specification

(Fourth Revision)

ICS 77.140.50

© BIS 2017



भारतीय मानक ब्यूरो

BUREAU OF INDIAN STANDARDS

मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली-110002

MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG

NEW DELHI-110002

www.bis.org.in www.standardsbis.in

FOREWORD

This Indian Standard (Fourth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1970 and subsequently revised in 1992, 2002 and 2011. While reviewing the standard, in the light of experience gained during these years, the Committee decided to revise it to bring inline with the present practices being followed by the industry.

In this revision the following changes have been made:

- a) Standard title has been modified;
- b) Chemical and mechanical properties have been modified; permissible variation for product analysis also modified;
- c) New grade designation system has been adopted; simultaneously old designations have also been given in Annex A;
- d) Grade HR5 designations of IS 1079 : 2009 'Hot-rolled carbon steel sheet and strip' are included in this revision;
- e) New grades ferrite-bainite steel, multiphase steel and martensitic steels are added;
- f) Clauses are rearranged. Clauses **4.2, 6.3, 8.3.2, 11 and 18.2** are added. Clauses **1, 2, 3, 5, 6.2, 7.1, 7.2, 8.1.1, 8.2, 8.3, 9.1.1, 10.2, 15, 16, 17.1, 18.1 and 19** have been modified; and
- g) Requirements of dimensions and tolerances have been separated from the standard and adopted in IS/ISO 16160 : 2005 'Continuously hot-rolled steel sheet products — Dimensional and shape tolerances'.

For all the tests specified in this standard (chemical/physical/others), the method as specified in relevant ISO Standard may also be followed as an alternate method.

In the formulation of this standard, assistance has been derived from the following:

ISO 20805 : 2005	'Hot rolled steel sheet in coils of higher yield strength with improved formability and heavy thickness for cold forming'
DIN EN 10149-2 : 2013	'Hot rolled flat products made of high yield strength steels for cold forming'
DIN EN 10338 : 2015	'Hot rolled and cold rolled non-coated products of multiphase steels for cold forming'
JIS G 3134 : 2006	'Hot rolled high strength steel plate, sheet and strip with improved formability for automobile structural uses'
JFSA 1001 : 2014	'Hot rolled steel sheet and strip for automobile use'

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

HOT ROLLED STEEL SHEET, PLATE AND STRIP FOR FORMING AND FLANGING PURPOSES — SPECIFICATION (*Fourth Revision*)

1 SCOPE

This standard covers the requirements of hot rolled steel sheet, plate and strip products for flanging and forming applications required for the manufacture of automobiles, integral coaches and general engineering purpose use where guaranteed mechanical properties and suitability for flanging and forming simple cold pressed parts are necessary.

2 REFERENCES

The following standards contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

<i>IS No.</i>	<i>Title</i>
228 (In various parts)	Methods of chemical analysis of steels
1599 : 2012	Metallic materials — Bend test (<i>third revision</i>)
1608 : 2005	Metallic materials — Tensile testing at ambient temperature (<i>third revision</i>)
1730 : 1989	Dimensions for steel plates, sheets strips and flats for general engineering purposes (<i>second revision</i>)
1757 (Part 1) : 2014	Metallic materials — Charpy pendulum impact test: Part 1 Test method (<i>third revision</i>)
1852 : 1985	Rolling and cutting tolerances for hot rolled steel products (<i>fourth revision</i>)
1956 (Part 4) : 2013	Glossary of terms relating to iron and steel: Part 4 Flat products (<i>second revision</i>)
3803 (Part 1) : 1989	Steel — Conversion of elongation values : Part 1 Carbon and low alloy steels.
8910 : 2010	General technical delivery requirements for steels and steel products (<i>first revision</i>)

IS No.

Title

IS/ISO 16160 : 2005	Continuously hot-rolled steel sheet products — Dimensional and shape tolerances
---------------------	---

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 1956 (Part 4) and the following definitions shall apply.

3.1 Thermo-Mechanical Rolling — A hot rolling process in which the final deformation is carried out in a certain temperature range to get fine microstructure which is achieved due to finely distributed precipitates mostly carbides and/or nitrides, leading to a material condition with certain properties that cannot be achieved or repeated by heat treatment alone, and such deformation is followed by cooling, possibly with increased cooling rates, with or without tempering, self-tempering included.

NOTE — Subsequent heating above 580°C typically can lower the strength values.

3.2 Normalizing Rolling — A hot rolling process in which the final deformation is carried out within a certain temperature range equivalent to normalizing temperature, leading to a material condition equivalent to that obtained after normalizing, such that the specified mechanical properties would still be met in the event of any subsequent normalizing.

3.3 Ferritic-Bainitic Steel (High Hole Expansion) — Steel exhibit good hole expansion than regular HSLA steel. Steel contains matrix of ferrite and strengthened ferrite containing bainite or strengthened bainite as second phase.

3.4 Dual-Phase Steel — Steel with very high tensile strengths and low yield ratio. Steel consisting of mainly ferrite and martensite and possible bainite as a complementary phase.

3.5 Multiphase Steel — Multiphase steels have multiphase microstructure contains ferrite matrix with fractions of bainite, martensite, tempered martensite, retained austenite and pearlite.

3.6 Martensitic Steel — Martensitic steels have mainly martensite matrix with small amounts of ferrite and/or bainite.

4 SUPPLY OF MATERIALS

4.1 General requirements relating to the supply of material shall conform to IS 8910.

4.2 Material shall be supplied either with mill edges or flattened and sheared or trimmed/slit edges.

5 DESIGNATION AND GRADES

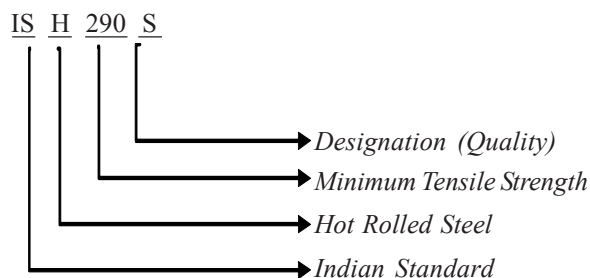
There shall be 36 grades of hot rolled steel plates, sheets and strips designated in Table 1.

Table 1 Designation and Grades
(Clause 5)

Sl No.	Grade	Designation (Quality)
i)	ISH290S	Structural steel
ii)	ISH310S	
iii)	ISH330S	
iv)	ISH360S	
v)	ISH370S	
vi)	ISH400S	
vii)	ISH410S	
viii)	ISH440S	
ix)	ISH490S	
x)	ISH320LA	High strength low alloy (HSLA) steel – High yield ratio type steel
xi)	ISH360LA	
xii)	ISH390LA	
xiii)	ISH410LA	
xiv)	ISH430LA	
xv)	ISH450LA	
xvi)	ISH480LA	
xvii)	ISH500LA	
xviii)	ISH550LA	
xix)	ISH600LA	
xx)	ISH650LA	
xxi)	ISH700LA	
xxii)	ISH750LA	
xxiii)	ISH440R	High strength structural steel (HSLA type)
xxiv)	ISH490R	
xxv)	ISH540R	
xxvi)	ISH590R	
xxvii)	ISH780R	Ferrite-bainite steel (hole expansion type)
xxviii)	ISH440F	
xxix)	ISH540F	
xxx)	ISH590F	Dual phase steel
xxxi)	ISH540Y	
xxxii)	ISH590Y	
xxxiii)	ISH780Y	Multi phase steel
xxxiv)	ISH750MP	
xxxv)	ISH980MP	Martensitic steel
xxxvi)	ISH1180MS	

NOTE — Grades are defined based on the minimum tensile strength required.

5.1 Nomenclature for new designation and grades is as follows:



6 MANUFACTURE

6.1 Steel shall be manufactured by any process of steel making except Bessemer process. It may be followed by secondary refining or secondary vacuum treatment.

6.2 Steel shall be semi-killed or killed. However, except structural type steel, all other grades shall be supplied in killed condition only.

6.3 Subject to prior agreement between the manufacturer and the purchaser, a suitable protective treatment may be given to the material. Applicable type of oiling is as per Table 2.

7 CHEMICAL COMPOSITION

7.1 Ladle Analysis

Ladle analysis of the material when carried out either by the method specified in the relevant part of IS 228 or any other established instrumental/chemical method, shall be as given in Table 3 and Table 4. In case of dispute, the procedure given in the relevant Part of IS 228 shall be the referee method.

7.2 Product Analysis

The permissible variation in the case of product analysis from the limits specified in Table 3 and Table 4 shall be as given in Table 5.

Table 2 Type of Oiling
(Clause 6.3)

Type of Oiling		As Hot Rolled	Pickling	Skin Pass	Shot Blast
Normal rust preventive oil ¹⁾		<i>x</i>	√	<i>x</i> / √	√
Special rust preventive oil ²⁾	High lubrication rust preventive oil ³⁾	<i>x</i>	√	<i>x</i> / √	<i>x</i>
	Solid lubricant ⁴⁾	<i>x</i>	√	<i>x</i> / √	<i>x</i>
No Oiling		<i>x</i>	<i>x</i> / √	<i>x</i> / √	<i>x</i>

Where *x* = Not applicable, √ = Applicable, and *x*/√ = Not applicable or applicable as per mutual agreement.

¹⁾ Commonly used for steel strip, plate and sheet for rust prevention.

²⁾ Special rust preventive oil is applied to the steel sheet, plate and strip with pickling finish.

³⁾ The rust preventive oil in combined use as press oil and rust preventive oil. This kind of oil shall be mutually agreed.

⁴⁾ Solid lubricant is for better frictional properties during press work. This kind of lubricant shall be mutually agreed.

NOTES

1 Guarantee of rust prevention is depend on type of oil and quantity of oil. Purchaser should evaluate before confirming the oiling.

2 For material ordered 'No Oiling', there is risk of rusting of steel. In that case, supplier has no responsibility if oxidation/rusting occur.

Table 3 Chemical Composition
(Clauses 7.1 and 7.2)

Sl No.	Quality		Constituent, Percent, Max						
	Grade	Designation	C	Mn	Si	P	S	Micro-Alloy	CE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	ISH290S	Structural steel	0.12	0.60	0.50	0.040	0.040	0.15	-
ii)	ISH330S		0.15	0.80	0.50	0.040	0.040	0.15	-
iii)	ISH360S		0.17	1.20	0.50	0.040	0.040	0.15	-
iv)	ISH410S		0.20	1.30	0.50	0.040	0.040	0.15	0.42
v)	ISH490S		0.24	1.60 ¹⁾	0.50	0.040	0.040	0.15	0.50
vi)	ISH320LA	High strength low alloy – High yield ratio type steel	0.12	1.20	0.50	0.025	0.020	0.22	=
vii)	ISH360LA		0.12	1.20	0.50	0.025	0.020	0.22	=
viii)	ISH390LA		0.12	1.30	0.50	0.025	0.020	0.22	=
ix)	ISH410LA		0.12	1.40	0.50	0.025	0.020	0.22	=
x)	ISH430LA		0.12	1.50 ¹⁾	0.50	0.025	0.020	0.22	=
xi)	ISH450LA		0.12	1.50 ¹⁾	0.50	0.025	0.020	0.22	=
xii)	ISH480LA		0.12	1.50 ¹⁾	0.50	0.025	0.015	0.22	=
xiii)	ISH500LA		0.12	1.60 ¹⁾	0.50	0.025	0.015	0.22	²⁾
xiv)	ISH550LA		0.12	1.70	0.50	0.025	0.015	0.22	²⁾
xv)	ISH600LA		0.12	1.80	0.50	0.025	0.015	0.22	²⁾
xvi)	ISH650LA		0.12	1.90	0.50	0.025	0.015	0.22	²⁾
xvii)	ISH700LA		0.12	2.00	0.60	0.025	0.015	0.22	²⁾
xviii)	ISH750LA		0.12	2.10	0.60	0.025	0.015	0.22	²⁾

Table 4 Chemical Composition

(Clauses 7.1 and 7.2)

Sl No.	Quality		Constituent, Percent, Max						
	Grade	Designation	C	Mn	Si	P	S	Micro-Alloy	CE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	ISH310S	Structural steel	0.15	0.80	0.50	0.040	0.030	0.15	-
ii)	ISH370S		0.17	1.20	0.50	0.040	0.030	0.15	-
iii)	ISH400S		0.20	1.30	0.50	0.040	0.030	0.15	0.42
iv)	ISH440S		0.24	1.50 ¹⁾	0.50	0.040	0.030	0.15	0.45
v)	ISH440R	High strength structural steel (HSLA type)	0.20	1.50 ¹⁾	0.50	0.030	0.020	0.20	2)
vi)	ISH490R		0.20	1.60 ¹⁾	0.50	0.030	0.020	0.20	2)
vii)	ISH540R		0.20	1.70	0.50	0.030	0.020	0.20	2)
viii)	ISH590R		0.20	1.80	2)	0.030	0.020	0.20	2)
ix)	ISH780R		0.20	2.00	2)	0.030	0.020	0.25	2)
x)	ISH440F	Ferrite-bainite steel (hole expansion type)	0.16	1.60	2)	2)	0.020	0.20	2)
xi)	ISH540F		0.16	1.80	2)	2)	0.020	0.20	2)
xii)	ISH590F		0.16	2.00	2)	2)	0.020	0.20	2)
xiii)	ISH540Y	Dual phase steel	0.16	1.80	2)	2)	0.020	0.20	2)
xiv)	ISH590Y		0.16	2.00	2)	2)	0.020	0.22	2)
xv)	ISH780Y		0.16	2)	2)	2)	0.020	0.25	2)
xvi)	ISH750MP	Multi phase steel	0.18	2)	2)	2)	0.015	0.35	2)
xvii)	ISH980MP		0.23	2)	2)	2)	0.015	0.35	2)
xviii)	ISH1180MS	Martensitic steel	0.25	2)	2)	2)	0.015	0.40	2)

NOTES (For both Tables 3 & Table 4)

- 1 Steels of these grades can be supplied with the addition of micro-alloying elements like Boron, Titanium, Niobium and Vanadium either singly or in combination as per above table. However, Boron addition will be restricted to 0.006 percent maximum.
- 2 The nitrogen content of the steel shall not be more than 0.009 percent. For aluminium killed or aluminium silicon killed the nitrogen content shall not exceed 0.012 percent. This shall be ensured by occasional checking.
- 3 When the steel is killed by aluminium the total aluminium content should not be less than 0.02 percent. However, aluminium less than 0.02 percent can be mutually agreed to between the purchaser and the supplier for aluminium killed steel. When steel is silicon killed the silicon content shall not be less than 0.1 percent. When the steel is aluminium silicon killed the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.
- 4 The material may be supplied in the copper bearing quality in which case the copper shall be between 0.20 and 0.35 percent on analysis.
- 5 The elements (for example Cr, Mo, Ni, etc) not mentioned in above table can be added upto 1.0 percent maximum either singly or in combination.
- 6 Restricted chemical composition may be mutually agreed to between the purchaser and the supplier.
- 7 Carbon equivalent (CE) based on ladle analysis = $C + \frac{Mn}{6} + \frac{(Cr+Mo+V)}{5} + \frac{(Ni+Cu)}{15}$

¹⁾ For each reduction of 0.01 below the specified maximum percent carbon, an increase of 0.05 percent manganese over the specified maximum up to 1.65 is permitted.

²⁾ As per mutual agreement between the supplier and the purchaser.

Table 5 Permissible Variation for Product Analysis
(Clause 7.2)

S1 No.	Constituent	Percentage Limit of Constituent	Variation Over the Specified Maximum Limit Percent, <i>Max</i>
(1)	(2)	(3)	(4)
i)	Carbon	≤ 0.15	0.02
		> 0.15	0.03
ii)	Manganese	≤ 0.6	0.03
		> 0.60 to ≤ 1.15	0.04
		> 1.15	0.05
iii)	Sulphur	≤ 0.05	0.005
iv)	Phosphorus	≤ 0.05	0.005
		> 0.05	0.010
v)	Silicon	≤ 0.60	0.03
		> 0.60	0.06
vi)	Copper	≤ 0.35	0.03
vii)	Micro Alloy	-	Subject to mutual agreement between the purchaser and the supplier.

NOTES

1 Product analysis shall not be applicable to rimming steel.

2 For carbon content less than 0.10 percent variation over specified limit can be mutually agreed to between the purchaser and the manufacturer.

8 TENSILE TEST

8.1 Number of Tensile Tests

One tensile test shall be taken from each cast.

8.1.1 Where plates, sheets and strips of more than one thickness are rolled from the same cast, one additional tensile test shall be made from the material:

- a) In the case of sheets and strips (for thickness $\leq 5\text{mm}$) — One sample shall be tested for thickness $< 2.0\text{ mm}$, One sample shall be tested for thickness between ≥ 2.0 and $< 3.20\text{ mm}$ and one sample shall be tested for thickness $\geq 3.20\text{mm}$.
- b) In the case of plates and strips (for thickness $> 5\text{mm}$) — For each variation thickness of 3 mm from the thickness of test piece first selected.

8.2 Tensile Test Pieces

The sampling position of test piece shall be at a quarter-width from the edge of the sheet and strip. If this is infeasible, the sampling should be made as close to the aforementioned position as possible.

Unless otherwise mentioned tensile test piece direction shall be cut transverse to the rolling direction and shall be of full thickness of the material. If agreed between the supplier and purchaser different orientation test piece may be used, but the values shall be as per Table 6 and Table 7. Selection of gauge length can also be mutually agreed between supplier and purchaser.

8.2.1 Tensile test pieces shall be of dimensions as specified in IS 1608.

8.3 Tensile Test

When tested in accordance with IS 1608 as applicable, the mechanical properties shall be as given in Table 6 and Table 7.

8.3.1 If the percentage elongation of any test piece is less than that specified in Table 6 and Table 7, and if any part of the fracture is outside the middle half of the gauge length as scribed before the test, the test shall be discarded and a retest shall be carried out.

8.3.2 Additional product characteristics can be agreed to between the purchaser and the supplier.

Table 6 Tensile Properties (Tensile Strength Range Specified)
(Clauses 8.2, 8.3 and 8.3.1)

Sl No.	Grade	Yield Strength, (Yield Point Proof Stress) <i>Min</i> MPa	Tensile Strength MPa	Percentage Elongation After Fracture A, <i>Min</i>	
				$GL = 80 \text{ mm}$ ($t \leq 3 \text{ mm}$)	$5.65\sqrt{S_0}$ ($t > 3 \text{ mm}$)
(1)	(2)	(3)	(4)	(5)	(6)
i)	ISH290S	165	290-400	22	30
ii)	ISH330S	205	330-440	20	28
iii)	ISH360S	235	360-470	19	26
iv)	ISH410S	255	410-520	17	23
v)	ISH490S	355	490-630	16	20
vi)	ISH320LA	255	320-420	25	27
vii)	ISH360LA	300	360-460	23	25
viii)	ISH390LA	315	390-510	20	24
ix)	ISH410LA	340	410-520	20	23
x)	ISH430LA	355	430-550	19	23
xi)	ISH450LA	380	450-570	18	21
xii)	ISH480LA	420	480-620	16	19
xiii)	ISH500LA	450	500-670	14	18
xiv)	ISH550LA	500	550-700	12	14
xv)	ISH600LA	550	600-760	12	14
xvi)	ISH650LA	600	650-820	11	13
xvii)	ISH700LA ¹⁾	650	700-880	10	12
xviii)	ISH750LA ¹⁾	700	750-950	10	12

Table 7 Tensile Properties with Yield Strength Range and Elongation Range Specified
(Clauses 8.2, 8.3 and 8.3.1)

Sl No.	Grade	Yield Strength (Yield Point/Proof Stress), MPa				Tensile Strength MPa	Percentage Elongation After Fracture A, Min						Hole Expansion % Min
		$t < 2$	$2 \leq t < 3.2$	$3.2 \leq t < 6.3$	$t \geq 6.3$		$t < 2$	$2 \leq t < 3.2$	$3.2 \leq t < 6.3$	$t \geq 6.3$	$t \leq 3$	$t > 3$	
							GL $L_0 = 50 \text{ mm}$				GL $L_0 = 80 \text{ mm}$	GL $L_0 = 5.6 \sqrt{S_0}$	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
i)	ISH310S	195 Min	185 Min	175 Min	165 Min	310 Min	33	34	38	40	²⁾	²⁾	—
ii)	ISH370S	225 Min	215 Min	205 Min	195 Min	370 Min	32	33	36	38	²⁾	²⁾	—
iii)	ISH400S	245-375	235-355	225-345	215 Min	400 Min	31	33	35	37	²⁾	²⁾	—
iv)	ISH440S	285-400	275-390	265-380	255 Min	440 Min	29	30	33	34	²⁾	²⁾	—
v)	ISH440R	305-450	305-440	305-430	295 Min	440 Min	26	27	28	29	²⁾	²⁾	—
vi)	ISH490R	375-500	365-490	355-480	345 Min	490 Min	22	23	24	25	²⁾	22	—
vii)	ISH540R	430-570	420-560	410-550	400 Min	540 Min	19	20	21	22	²⁾	19	—
viii)	ISH590R	480-630	470-620	450-610	450 Min	590 Min	17	18	19	20	²⁾	17	—
ix)	ISH780R	—	685-835	675-825	675 Min	780 Min	—	14	15	15	²⁾	12	—
x)	ISH440F	285-420	275-420	265-420	265 Min	440 Min	29	30	33	²⁾	22	25	100
xi)	ISH540F	375-540	365-530	355-520	355 Min	540 Min	22	23	24	²⁾	17	20	80
xii)	ISH590F	460-620	450-620	440-620	440 Min	590 Min	18	19	20	²⁾	15	17	75
xiii)	ISH540Y	305-450	295-440	295-440	295 Min	540 Min	24	25	26	²⁾	19	23	—
xiv)	ISH590Y	²⁾	325-490	325-490	325 Min	590 Min	22	23	24	²⁾	17	20	—
xv)	ISH780Y	—	390-635	380-625	380 Min	780 Min	—	16	17	²⁾	12	15	—
xvi)	ISH750MP	—	650-830	650-830	650 Min	750 Min	—	²⁾	²⁾	²⁾	10	12	—
xvii)	ISH980MP	—	780-1000	780-1000	780 Min	980 Min	—	²⁾	²⁾	²⁾	5	6	—
xviii)	ISH1180MS	—	920-1200	920-1200	900 Min	1 180 Min	—	²⁾	²⁾	²⁾	4	5	—

NOTES (For both Tables 6 and Table 7)

1 Grade ISH290S may be supplied based on chemical composition only, if agreed to between the manufacturer and the purchaser.

2 The non-proportional test piece with a fixed gauge length, up to 5 mm thick sheet can be used in conjunction with a conversion table in accordance with IS 3803. In case of dispute, however, only results obtained on a proportional test piece will be valid for material over 3 mm in thickness.

3 Where, t is thickness, GL = Gauge length, and S_0 — Original cross-sectional area of gauge length.

4 The yield stress values apply to the 0.2 percent proof stress, if the yield stress is not clearly distinctive, otherwise the values apply to the lower yield stress.

5 Restricted properties along with maximum values on YS in grades ISH310S and ISH370S and elongation may be agreed to between the purchaser and the manufacturer.

¹⁾ For thickness >8mm the minimum yield strength can be 20 MPa lower.

²⁾ Properties on mutual agreement between the purchaser and the manufacturer.

9 BEND TEST

9.1 Number of Bend Test

One bend test shall be taken from each cast.

9.1.1 Where plates, sheets and strips of more than one thickness are rolled from the same cast, one additional bend test shall be made from the material:

- In the case of sheets and strips (for thickness $\leq 5 \text{ mm}$) — One sample shall be tested for thickness $< 2.0 \text{ mm}$, One sample shall be tested for thickness between ≥ 2.0 and $< 3.20 \text{ mm}$ and one sample shall be tested for thickness $\geq 3.20 \text{ mm}$.
- In the case of plates and strips (for thickness $> 5 \text{ mm}$) — For each variation thickness of 3 mm from the thickness of test piece first selected.

9.2 The bend test shall be carried out in accordance with IS 1599.

9.2.1 Bend test piece shall be cut so that the axis of the bend is parallel to the direction of rolling that is the longer axis of the test piece shall be 90° to the direction of rolling.

9.2.2 The test piece shall be bend cold through 180° . The internal diameter of the bend for the different grades of material shall be as given in Table 8. The test piece shall be deemed to have passed the test, if the outer convex surface is free from cracks.

9.2.3 It is some time difficult to ensure that the material is accurately following the radius. In case of dispute, the test piece may be pushed into a block of lead by a former of appropriate diameter.

Table 8 Bend Test Requirement for Hot Rolled Steel Plates, Sheets and Strip

(Clause 9.2.2)

Sl No.	Grade	Internal Diameter of Bend Thickness	
		Up to and Including 12 mm	Above 12 mm
(1)	(2)	(3)	(4)
i)	ISH290S	Close	1t
ii)	ISH310S	1t	2t
iii)	ISH330S	1t	2t
iv)	ISH360S	1t	2t
v)	ISH370S	1t	2t
vi)	ISH400S	1t	2t
vii)	ISH410S	1t	2t
viii)	ISH440S	1t	2t
ix)	ISH490S	2t	3t
x)	ISH320LA	Close	1t
xi)	ISH360LA	Close	1t
xii)	ISH390LA	Close	1t
xiii)	ISH410LA	0.5t	2t
xiv)	ISH430LA	1t	2t
xv)	ISH450LA	1t	2t
xvi)	ISH480LA	1t	2t
xvii)	ISH500LA	1t	2t
xviii)	ISH550LA	1.5t	2t
xix)	ISH600LA	1.5t	2t
xx)	ISH650LA	2t	3t
xxi)	ISH700LA	2t	3t
xxii)	ISH750LA	2t	3t
xxiii)	ISH440R	1t	2t
xxiv)	ISH490R	1.5t	2.5t
xxv)	ISH540R	1.5t	2.5t
xxvi)	ISH590R	1.5t	2.5t
xxvii)	ISH780R	2t	1)
xxviii)	ISH440F	1t	1)
xxix)	ISH540F	1.5t	1)
xxx)	ISH590F	1.5t	1)
xxxi)	ISH540Y	1.5t	1)
xxxii)	ISH590Y	1.5t	1)
xxxiii)	ISH780Y	2t	1)
xxxiv)	ISH750MP	1)	1)
xxxv)	ISH980MP	1)	1)
xxxvi)	ISH1180MS	1)	1)

NOTE —Where 't' is the thickness of test piece. Restricted Internal diameter of the bend may be agreed to between the purchaser and the manufacturer.

1) Properties on mutual agreement between the purchaser and the manufacturer.

10 IMPACT TEST

10.1 If agreed at the time of enquiry and stated in the order impact test shall normally be carried out on products having thickness greater than or equal to 12 mm. The test specimen shall be machined in such a way that the axis of the test specimen is parallel to the direction of rolling and the base closer to the roll surface is more than or equal to 1 mm from it. The notch axis shall be perpendicular to the roll surface.

10.2 Under this standard, the average V-notch bar impact strength (average of 3 tests carried out on 3 test pieces taken side by side from the same product)

- For grades ISH290S to ISH490S: shall not be less than 27J with no individual test value less than 18 J when tested at room temperature.
- For grades ISH320LA to ISH750LA (High Strength Low Alloy – High yield ratio type steel): shall not be less than 40J with no individual test value less than 27 J when tested at -20°C.

More stringent values at room temperature and values at different temperature may be mutually agreed between the supplier and the purchaser.

10.3 If agreed at the time of enquiry and stated in the order impact tests may be carried out on products having thickness less than 12 mm, the dimensions of test piece shall be as specified in IS 1757 (Part 1). The average impact value required for material less than 12 mm and more than 25 mm thick will be as per mutual agreement between the purchaser and the manufacturer.

10.4 A test sample shall be taken from each heat. If different thicknesses have been rolled from slabs of a same heat, test sample shall be taken from the thickest products. If this thickest product test sample meets the requirement, all subsequent lower thicknesses rolled from the same cast/heat shall be deemed to satisfy the specification. If the sample does not meet the requirement, the test shall be carried out on the next thickest product and so on.

11 HOLE EXPANSION RATIO TEST

For hole expansion ratio test, the test method from relevant ISO Standard may be followed or it may be as mutually agreed to between the purchaser and the manufacturer.

12 RETEST

If a test does not give the specified results, two additional tests shall be carried out at random on the same lot. Both retests shall confirm to the

requirements of this standard, otherwise the lot shall be rejected.

13 FREEDOM FROM DEFECTS

13.1 Sheets, strips, plates and flats shall be closely rolled to the dimensions specified. The finished material shall be free from harmful defects and shall be reasonably smooth and flat. Repair by welding shall not be undertaken by the supplier without the permission of the purchaser.

13.2 When the material is supplied in the form of coils, the degree or amount of surface defects are expected to be more than in cut length sheets since the inspection of coils does not afford the same opportunity to reject portion continuing defects as with cut lengths. However, an excessive amount of defects may be a cause for rejection.

13.3 In case of plates, scale pits and other minor surface defects may be removed by grinding, the depth of grinding being such that the thickness of the plate shall not go below the specified value, at the spot where dressing is done. The grinding shall be even and smooth and shall be widened enough to remove sharp ridges. Dressing with a hammer or welding of defective spots shall not be permitted.

14 WELDABILITY

All steels complying with the standard are of weldable quality. The material shall be suitable for gas welding, arc welding, spot welding and rollerseam welding. At the time of ordering, required welding if any shall be communicated.

15 DIMENSIONS AND TOLERANCES

15.1 Unless otherwise agreed to between the supplier and the purchaser, standard dimensions of hot rolled steel plates, sheets, strips and flats shall confirm to those given in IS 1730.

15.2 Unless otherwise agreed the dimensional tolerances for hot-rolled steel shall be as given in IS/ISO 16160 and IS1852 for plates from plate mill and also for sizes and tolerances not covered in IS/ISO 16160.

15.2.1 Unless otherwise agreed the restricted thickness tolerances shall be as given in IS/ISO 16160.

16 CALCULATION OF MASS

Material shall be supplied on the basis of actual weight. If weighing is not possible, the mass of the steel shall be calculated on the basis of steel density 7.85 g/cm³.

17 DELIVERY

17.1 The material may be supplied in any one (or, in combination) of the following conditions subject to mutual agreement between the supplier and the purchaser:

- a) Hot rolled:
 - 1) As rolled,
 - 2) Thermo mechanically rolled,
 - 3) Normalizing rolling (delivery condition is +N),
- b) Annealed,
- c) Normalized,
- d) Pickled (descaled),
- e) Pickled and oiled,
- f) Skin passed,
- g) Skin passed and oiled, and
- h) Shot blasted.

Unless and otherwise agreed, material shall be supplied in hot rolled condition (As rolled).

17.2 Subject to prior agreement between the manufacturer and the purchaser, a suitable protective treatment may be given to the material.

18 MARKING AND PACKING

18.1 Plates and sheets shall be supplied in bundles, and strips in coils. Each bundle shall carry a metal tag or adhesive label/sticker bearing the cast number or identification mark or lot number traceable to the cast number and the manufacturer's name or trade-mark. Alternatively, top sheet/plate shall be legibly marked with the cast number or identification mark or lot number traceable to the cast number, name of the manufacturer or trade-mark.

18.2 Unless otherwise agreed the packing shall be adequate to ship the material safely and in good condition.

18.3 BIS Certification Marking

The material may also be marked with the Standard Mark.

18.3.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made there under. The details of conditions under which the license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

19 ORDERING INFORMATION

While placing an order, the following are the minimum information to be specified by the purchaser:

- a) Grade;
- b) Size;
- c) Mass of the material;
- d) Total order quantity;
- e) Marking instructions other than specified, if any;
- f) Restricted chemistry and/or properties, if used for special purpose;
- g) Dimensional tolerances, if any special agreement to be made; and
- h) Supply condition (edge condition, delivery conditions and type of oiling if any, etc).

ANNEX A
(Foreword)

CORRELATION OF OLD AND NEW GRADES/DESIGNATIONS

<i>Sl No.</i>	<i>Grade</i>	<i>Designation</i>	<i>Old Designation / Equivalent Designation</i>
i)	ISH290S	Structural steel	Grade 165/ -
ii)	ISH310S		-
iii)	ISH330S		Grade 205/ -
iv)	ISH360S		Grade 235/ -
v)	ISH370S		—
vi)	ISH400S		—
vii)	ISH410S		Grade 255/ -
viii)	ISH440S		—
ix)	ISH490S		—
x)	ISH320LA	High strength low alloy – High yield ratio type steel	- /IS 1079 : 2009 HR5-YST255
xi)	ISH360LA		- /IS 1079 : 2009 HR5-YST305
xii)	ISH390LA		—
xiii)	ISH410LA		Grade 325/IS 1079 : 2009 HR5-YST340
xiv)	ISH430LA		Grade 355/ -
xv)	ISH450LA		- /IS 1079 : 2009 HR5-YST380
xvi)	ISH480LA		Grade 420/ -
xvii)	ISH500LA		- /IS 1079 : 2009 HR5-YST450
xviii)	ISH550LA		Grade 490/IS 1079 : 2009 HR5-YST500
xix)	ISH600LA		Grade 560/ -
xx)	ISH650LA		—
xxi)	ISH700LA		—
xxii)	ISH750LA		—
xxiii)	ISH440R	High strength structural steel (HSLA type)	—
xxiv)	ISH490R		—
xxv)	ISH540R		—
xxvi)	ISH590R		—
xxvii)	ISH780R		—
xxviii)	ISH440F	Ferrite-bainite steel (Hole expansion type)	—
xxix)	ISH540F		—
xxx)	ISH590F		—
xxxi)	ISH540Y	Dual phase steel	—
xxxii)	ISH590Y		- /IS 1079:2009 HR5-DP590
xxxiii)	ISH780Y		- /IS 1079:2009 HR5-DP780
xxxiv)	ISH750MP	Multi-phase steel	—
xxxv)	ISH980MP		—
xxxvi)	ISH1180MS	Martensitic steel	—

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: MTD 04 (5365).

Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002

Telephones: 2323 0131, 2323 3375, 2323 9402

Website: www.bis.org.in

Regional Offices:

Telephones

Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	{ 2323 7617 2323 3841
Eastern	: 1/14, C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	{ 2337 8499, 2337 8561 2337 8626, 2337 9120
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg, CHANDIGARH 160019	{ 26 50206 265 0290
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	{ 2254 1216, 2254 1442 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	{ 2832 9295, 2832 7858 2832 7891, 2832 7892

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESWAR. COIMBATORE.
DEHRADUN. DURGAPUR. FARIDABAD. GHAZIABAD. GUWAHATI.
HYDERABAD. JAIPUR. JAMSHEDPUR. KOCHI. LUCKNOW. NAGPUR.
PARWANOO. PATNA. PUNE. RAIPUR. RAJKOT. VISAKHAPATNAM.

Published by BIS, New Delhi